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Meteor Showers. By W. F. Denning, Esq.

Several meteor streams observed at Bristol within the last two years appear to be of such marked intensity as to merit special description, and the following notes may be of some use to those who desire to reobserve the annual returns of the showers referred to. I have selected five positions from the large number of radiant points determined since 1877, as under :—

		α δ	
		° °	
I	July 30—Aug. 1	32 + 53	Max. July 31, 1878.
II	July 27–30	341 – 13	Max. July 27–28, 1878-9.
III	August 21–25	291 + 60	Max. August 21–23, 1879.
IV	October 14–20	31 + 9	Max. October 15, 1879.
V	August 8–11	44 + 25	Max. August 10?

I. At the middle of July 1877 a few meteors were traced from a radiant point at 36° + 47°, and on projecting a large number of meteor tracks registered in foreign catalogues for the period July 25–31, I found the same shower amply manifested from 25 paths, though the radiant was 5° higher in declination. A succession of clear nights occurred from July 26 to August 2 in 1878, and I obtained some lengthy observations. In about 22 hours of watching more than 400 shooting stars were seen in the eastern sky, chiefly amongst the constellations of *Perseus*, *Cassiopeia*, and *Andromeda*. I saw many swift meteors leaving short streaks and otherwise exhibiting much uniformity in their appearances and directions. The radiant was evidently in *Perseus*, and at first I mistook them for early members of the closely approaching Perseïds of August 10, but soon found from a number of foreshortened paths that the radiant point was not reconcilable with that of the well-known annual shower. It was sharply defined about 3° S. of the group χ *Persei* and the maximum of the shower was witnessed on the last night of July, when 21 meteors were noted diverging from the same point below χ *Persei*. In all I saw 63 meteors conforming to this stream; they were short and quick, always with streaks of 3° or 4° in the latter portion of their flights. I looked for the shower again in 1879 and recovered it both on July 28 and 29. It appears to be identical with a radiant given by Schmidt at 31° + 55°, August 3–12. The diagram shows the observed paths of 86 $\downarrow^s$ (in the region of the radiant point) recorded at Bristol in the years 1877–8 and includes some tracks in the catalogues of foreign observers. Several of the meteors are apparently directed from a point slightly north of the position observed in 1878 and conform to a centre at χ *Persei* precisely; but I am fully satisfied that the true radiant lies quite 3° below that cluster. There is evidence of a prominent shower at about 32° + 57° on

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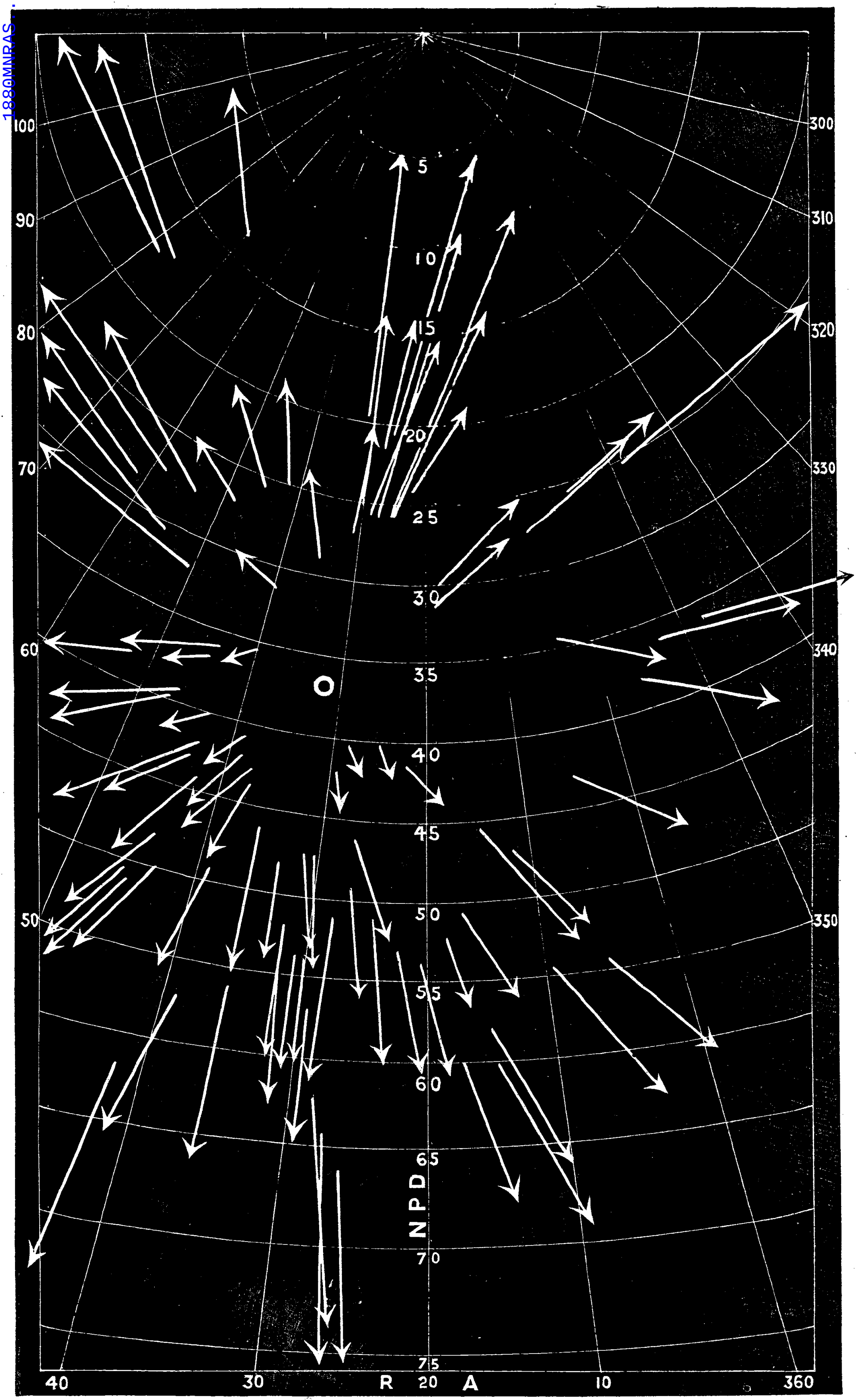

Fig. I.—Shower of χ Perseïds, or Perseïds II, near the radiant point $32^\circ + 53^\circ$, max. July 28—Aug. 1.

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August 10; but that is probably a different stream and one of the principal radiants of the major Perseïds.

II. Contemporary with these χ Perseïds, or Perseïds II, my observations in July 1878 led me to recognise a large number of slow meteors with long paths (averaging 17°) and occasionally leaving faint trails of sparks, ascending amongst the stars of *Pegasus*, *Andromeda*, &c., which, by their parallelism of motion, obviously proceeded from a common radiant point presumably situated at a low altitude and considerably southwards of *Pegasus*. I watched them narrowly, and determined the radiant with fair precision as near δ *Aquarii*. The best display of this fine shower was on July 27, when 22 of its meteors were recorded, but they were also numerous on the few ensuing nights. In the three-quarters of an hour preceding midnight on July 30, eight of these Aquariads were visible, though the radiant was close to the horizon; but on the following night the shower appeared to have become extinct. In 1879, July 28, it reappeared, giving very long gradual meteors similar to those seen the year before. In a watch of two hours ($11^h\ 45^m$ to $13^h\ 45^m$) on the night mentioned 45 shooting stars were counted, of which 14 were Aquariads diverging from the point 338° − 14°. Just before midnight the shower was in active progress, supplying several fine meteors brighter than the stars. The continuation of this radiant in August is rendered extremely probable by my observations in 1877, when I detected a good centre at 342° − 12° from twelve meteors,

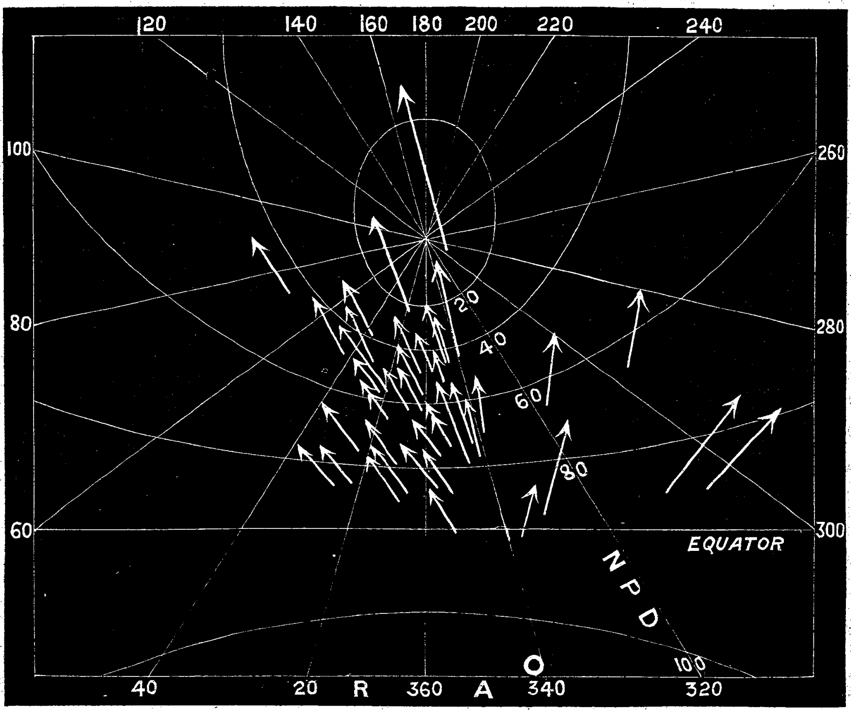

Fig. II.—Shower of Aquariads (341°—13°), max. July 27–30.

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August 3–16, and by a bright stationary meteor, also recorded at Bristol, on August 9, 1879, at 342°—16°. An observation very similar to the latter was obtained by Sawyer at Cambridgeport, Mass., on August 7, 1879, of a 2nd mag. stationary meteor at 344—°13°, and further proof of the shower's sustenance in August is afforded by several positions of Schmidt and Neumayer:—

	° °	
August 1–12	345 − 7	Schmidt.
August 1–31	341 − 11	Schmidt.
August 1–31	337 − 10	Neumayer.

Schmidt had also traced the shower in July, for he gives two positions for July 20–31 with a mean = 337°–11°; but Major Tupman had obtained the best previous observations of the shower. On July 27, 1870, and several ensuing nights, he saw many meteors from an accurate radiant at 340°–14°, and the position and epoch of the shower, as he determined it, agree perfectly with its apparition in 1878–79 recorded at Bristol. Prof. Herschel had also, as early as July 28, 1865, traced a few of its meteors. Later showers (of very slow meteors) from the same region of *Aquarius* appear in September and October, and are possibly prolonged into November; for on November 7, 1877, the Rev. S. J. Johnson, at Crediton, saw a 1st mag. meteor stationary at 338°—15°. The diagram shows 41 tracks registered at the end of July, chiefly in 1878, at Bristol.

III. Beginning to observe at about 9^h 30^m on August 21, 1879, I immediately found that a very active shower of slow trained meteors was proceeding from a point in *Draco*. I noted 9 of them in the $\frac{3}{4}^h$ before 10^h 15^m, though afterwards the shower became less decided, and of the 68 meteors which I counted up to 13^h 30^m (when clouds overspread the sky) 21 belonged to this system. The two ensuing nights were clear, and I saw 143 shooting stars, including 31 additional paths conforming to the special shower in *Draco*, the exact position of which I determined at 291°+60° (near *o Draconis*). The night of August 24 was overcast; but on the 25th I watched the sky at intervals between large breaks in the clouds and noted several fine meteors from the same radiant point. The total number directed from this stream was 56 out of an aggregate of 225 meteors seen on August 21, 22, 23, and 25. The Draconids were generally brilliant, with short paths and spark-trails; motions rather slow. Ten exceeded or equalled the 1st mag. and 15 were estimated = 2nd mag. The same shower was found by Tupman on August 20–25, 1871, at 280°+58°, and Corder saw it at 286°+61° (10 $\downarrow^{s}$) on about August 16, 1879. It is evidently identical with the Draconids II (No. 78) of Greg's *Catalogue of Meteor Showers* (1876), in which the position is averaged at 282°+60° and the whole duration extends from June 28 to August 25? from 12 observations. There are other conspicuous showers from the same region near *o Dra-*

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conis in April–May, and again in November and early in December, (*see* Greg's Nos. 64 and 166). The diagram gives 41 paths, nearly all of which were traced on August 21–23, 1879. These dates nearly coincide with a fireball epoch (August 19–22), and there is little doubt that the rich shower of Draconids referred to has furnished us (in conjunction with a shower of Cepheïds from near *β Cephei*) with a large proportion of the brilliant meteors observed at this season of the year.

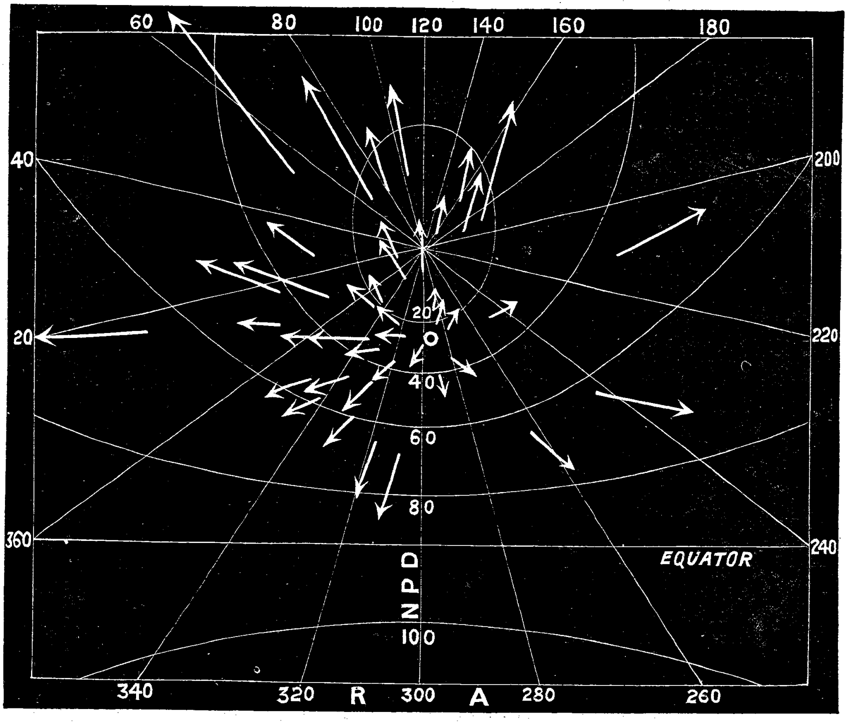

FIG. III.—Shower of Draconids (291° + 60°), max. Aug. 21–23.

IV. On October 15, 1879, the sky was watched for 11 hours ($6^h 30^m$ to $17^h 30^m$), and of the 127 shooting stars seen during that long observation, 21 were slow meteors from a radiant point at 31° + 9°, but the position was not well defined. I had seen several meteors from the same region on the previous night, and on the 20th, when the sky was again favourable, I recorded 10 others, making 37 in all from this shower in the south of *Aries*. They were generally faint, with rather short paths and decidedly slow. The same radiant was seen by Major Tupman in 1869, October 13, at 28° + 10°, and Mr. Corder has distinguished a series of positions in *Aries* and *Pisces*. He remarks that "there are several radiants of small meteors about this place in October, which are difficult to separate." At the middle of October 1879 he determined an active shower at 25° + 8° ($18 \downarrow^{s}$), and, towards the end of the same month, saw a radiant at 32° + 11° ($10 \downarrow^{s}$). Mr. Corder had also witnessed the two preceding apparitions of

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the shower, for in 1878, October, he tracked 17 paths from the point 37° + 10°, and in 1877, October, found a position at 30° + 10° (9 $\downarrow^{s}$). These several observations unquestionably refer to one and the same stream, situated approximately between *α Arietis* and *α Piscium*, and nearer the latter star; but there may be a few branch radiants closely adjoining, as suspected by Mr. Corder, and this would explain the apparently diffuse radiation of the meteors seen in 1879. The diagram (IV) includes 42 paths observed by me in the years 1876–79, but chiefly in 1879. The meteors were mostly seen amongst the stars of *Perseus* and *Taurus*, which I was watching at the time of the shower's appearance.

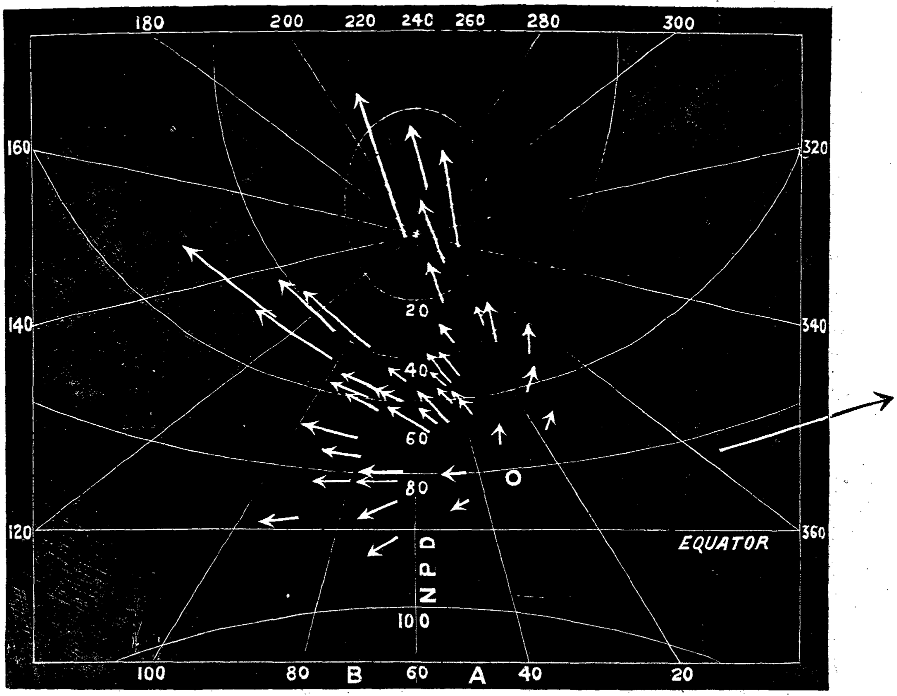

Fig. IV.—Shower of meteors from a radiant point at 31° + 9°, Oct. 14–20 (max. Oct. 15).

V. At about the middle of August 1877, a few rapid meteors were traced from a radiant in *Musca* at 40° + 28°, and in the following year, while noting the progress of the Perseïds, I recorded several fine meteors, leaving streaks and with paths averaging 40°. The radiant was evidently on the horizon, and the directions of the meteors, which in several instances were very exactly observed and mapped, indicated the point 44° + 25° as the diverging focus of the shower. With the object of further investigating it, I looked through the observations made at the epoch of the Perseïds, by the Italians in 1872 and by Zezioli in 1867–70, and found many meteors conforming to this same shower in *Musca*, which had already been detected by Weiss in 1869, August 11, $46\frac{1}{2}° + 23\frac{1}{2}°$, and August 12, $41\frac{1}{2}° + 24°$. Denza also appears to have seen it in 1869, August 10, at 48° + 19°;

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In this region, between *Musca* and the E. extremity of *Aries*, there are many successive showers during the four months from August to November. I have seen one in September (after the 20th), and again on October 8 and 15, October 31–November 4; and in the present year, on November 12–14, while observations were directed towards the stars of *Leo*, a large number of slow, bright meteors were seen both by myself and Mr. Corder from two very decided radiants of Taurids and Muscids. Early in August, when the first shower from *Musca* is perceptible, the meteors are very swift, with unusually long paths, and seldom without streaks; but in October and November the motions are generally slow, and the phosphorescent streaks, forming so persistent a feature of the earlier displays, have given way to occasional trains of ashy sparks. The August shower above referred to is not perhaps of special intensity, but it merits description as of contemporary occurrence with the Perseïds, and as supplying some fine long meteors in the mornings of August. Thirty-eight paths are shown in the diagram, several of which are notable on account of great length.

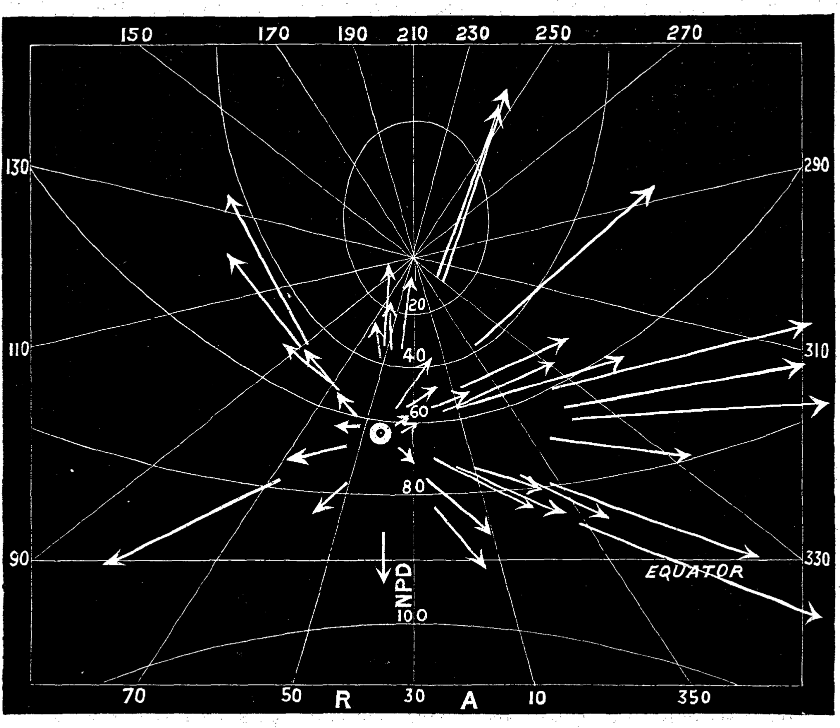

Fig. V.—Shower of Muscids (44°+25°), max. Aug. 8–11.

The several showers of χ Perseids, Aquariads, &c. here mentioned, being apparently of little less importance than the Orionids, Geminids, Taurids, &c., will no doubt be frequently seen in future years; and it seems desirable to select them from the mass of feeble systems now ascertained, as affording displays of more

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than ordinary richness. Many other similar examples of fairly active streams will be found as observations increase, and it will be necessary to single these out for special investigation.

Amongst the radiant points seen at Bristol during the last two years* a few others (in addition to those already specified) have exhibited signs of importance, and the dates and positions of these were as follows:—

	α	δ	↑•	
	°	°		
July 31—August 1	332	+ 50	14	Lacertids.
July 31—August 1	12	+ 70	16	
July 31—August 1	321	+ 31	10	ζ Cygnids.
August 21–23	319	+ 30	12	
August 1–2	291	+ 70	14	δ Draconids.
July 26—August 1	28	+ 36	12	Triangulids.
September 14–25	30	+ 36	16	
July 25–26	332	+ 37	11	
August 21–23	46	+ 47	9	α Perseïds.
September 14–25	99	+ 43	15	Lyncids.
October 14–20	95	+ 46	11	
September 21	31	+ 19	10	Arietids.
September 14–25	76	+ 32	17	Aurigids.
October 14–15	77	+ 57	19	
October 15	106	+ 23	11	Gemellids.
October 4–20	316	+ 59	17	α Cepheïds.

In each case the radiant may be regarded as accurate.

At the middle of September 1879 a shower was seen from *α Aurigæ*, and in July, September, October, and November many meteors have fallen from an exact centre 3° S. of *α Cassiopeiæ*.

Meteor Showers, 1870–1879. By Henry Corder, Esq.

(*Communicated by W. F. Denning, Esq.*)

The accompanying meteor radiant points have been culled from a list of about 230, chiefly observed between the years 1876–1879, the total number of meteors registered since 1870 being about 5,800, but of this time only the last three years have been made of much real use.

In mapping the meteors, rough star charts copied from an

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* The results obtained up to the end of 1877 have already appeared in the *Monthly Notices.* See vol. xxxvi., pp. 283–89; vol. xxxvii., pp. 105–15; and vol. xxxviii., pp. 303–14.